BABEŞ-BOLYAI UNIVERSITY, CLUJ-NAPOCA

FACULTY OF GEOGRAPHY

DOCTORAL SCHOOL OF GEOGRAPHY

PHD THESIS

- Summary -

THE STUDY OF NATURAL RISKS AS LIMITING FACTORS OF TOURISM ACTIVITIES IN CALIMANI MOUNTAINS

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INTRODUCTION

It is known that the environment and human society often bear the action of dangerous phenomena that can cause destructive disturbances in certain systems or situations. Mountain regions are no exception, with the mountains even more frequently affected than other environments.

Starting from these considerations and also because of my interest in the field of tourism I have chosen to approach this theme in the desire to carry out a complex study of natural risks as limiting factors of tourism activity. As a general analysis would not be relevant, I narrowed down the research area to the Calimani Mountains.

After having critically read the specialty literature, we found that this area had a limited approach to risk phenomena, let alone an approach which perceived dangerous phenomena as limiting factors of tourist activity, fact that added originality to this study.

Objectives

This study aims to go through and achieve the following objectives, starting with a critical and cognitive approach to risk phenomena, corroborated with maps, analyses based on the distribution of the factors leading to the production of these dangerous phenomena and the assessment of tourist sites and of the risks that they are subjected to or that might occur within these sites. The main objectives are as it follows:

- The bibliographic basis in the field and the deepening of the conceptual framework that will be used during the research;
- The analysis of the factors that contribute to triggering dangerous phenomena, with disruptive effects on tourism activity;
- The analysis of the typology of hazards whose incidence was reported in Călimani Mountains; identification, deployment and location of these dangerous phenomena;
- Mapping areas with a certain degree of danger and prioritizing the susceptible areas by developing a unitary quantification depending on their size unit
- Cartographic representation of areas susceptible to the production of certain dangerous phenomena

- Develop a digital map illustrating this hierarchy of susceptible areas
- Proposal for measures to combat and mitigate the effects of risk on tourist activity.

GENERAL ASPECTS

Călimani Mountains are an integral part of the Oriental Carpathians, being just like the entire Carpathian chain, creaking young mountains, formed in the alpino-carpathian Himalayan orogeny, about 70-85 million years ago. Călimani Mountains are of volcanic origin, the highest peak of which is 2100 m, the Pietrosul Călimanilor Peak.

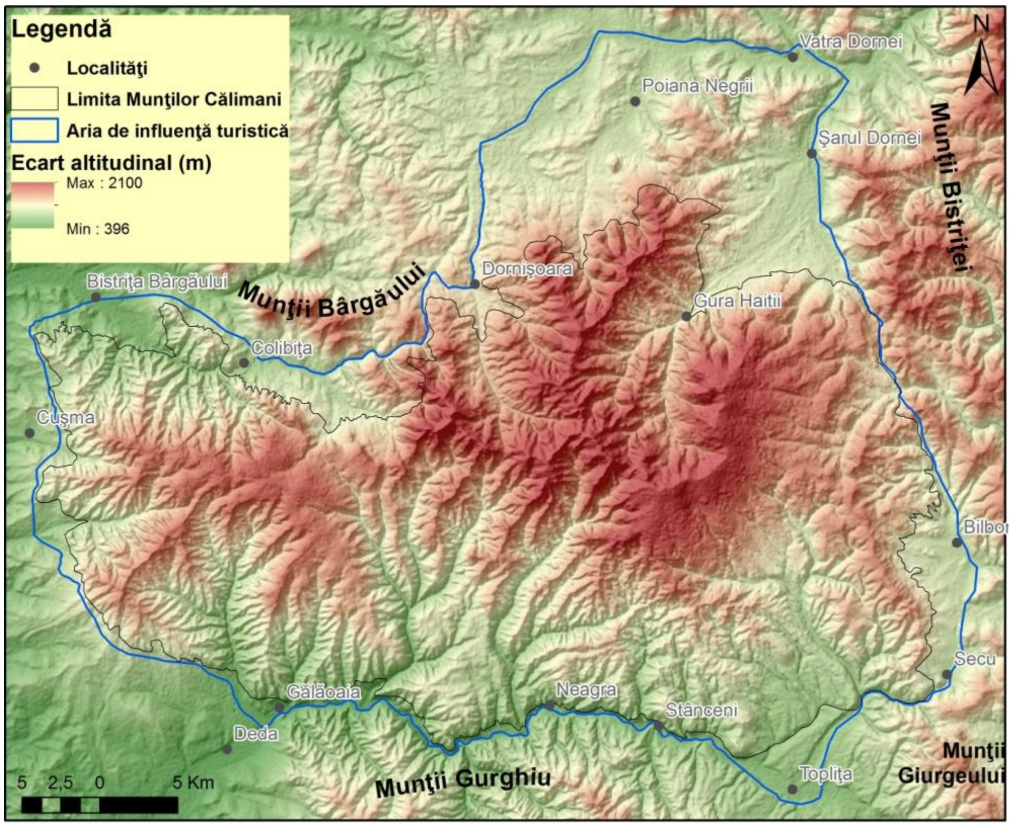

Figure 1 The limit of Calimani Mountains

CONCEPTUAL FRAMEWORK IN RISK STUDY

The specialty literature contains a set of formulas whose components differ according to the author's perspective and the analyzed situation. In a broad sense, the risk is seen as the simple product of hazard and vulnerability: R = HxV but simply monitoring the progress of a dangerous natural event clearly shows that separating its components in two, hazard and vulnerability can deprive this event of a clear perception and understanding. Demonstrative to this statement, that the risk has three components and not two, is the example of a storm, sustained and argued by Carrega P. (2010). According to him, in the case of a sudden flood, the hazard is not the actual flood, but the meteorological phenomena that will generate a heavy rainfall without flooding. He continues in his argumentation with a second and essential component that will make its effect clearer: the susceptibility. This component represents, in the case of a rainy interval, the totality of biophysical factors that may lead or not to a flood by certain elements: slope type, rock and soil permeability, the vegetation etc. In other words, the amount of rainfall collected will depend on the position of the storm related to the basin or the slope, as well as the rain intensity; the rise in water levels will also depend on the leakage rate itself determined by the susceptibility and the recent pluviometric events. At this stage, at the same site it is obvious that the same amount of rainfall will not lead to the same floods, or that two almost similar floods can originate from two different hazards, hence the role of susceptibility that may or may not turn into a violent drain (the flood) a certain rainfall (the hazard). The third component is, of course, the vulnerability that builds and develops around human activity (the destruction of buildings, roads, etc.), so the vulnerability is anthropic. For example, a flood would not have the same destructive effects if it had nothing to destroy.

METHODOLOGY TO CREATE SUSCEPTIBILITY MAPS

Two types of analysis are used to make susceptibility maps. The first type focuses on the frequency analysis of these events. Predicting such an event to occur is difficult and the best evidence of their frequency and severity is their history. In Romania and especially in the mountainous area, this information does not exist or is incomplete and inaccurate, so this type of analysis is impossible or extremely difficult to perform. In the present case, the only information on these issues is those in which these phenomena have resulted in the injury or even the death of tourists. As a result, in this study we chose the second type of analysis, which refers to the distribution of the factors that cause the production of dangerous phenomena that can negatively influence tourism activity. However, our analyses have been based on the numerous bivariate studies in which the occurrence of various extreme phenomena is known.

Therefore, an analysis based on the distribution of the factors causing the production of dangerous phenomena, corroborated with the studies that refer to them, is appropriate and even impetuous in the less known areas, as is the case of Călimani Mountains.

The GIS database used:

- Topographic maps 1:25000
- Pedological maps 1:200.000

- Ortophotomaps
- Digital Terrain Model (DTM) - Shuttle Radar Topography Mission (SRTM)
- Land use mode - CLC database
- Temperatures and precipitation from the WorldClim database

The derived GIS database

- Slope gradient
- Slope orientation
- Slope length (LS)

Overlaying thematic maps method

After the reclassification of each type of data, the overlay of thematic maps was applied using the "Raster Calculator" and "Mosaic to new raster" tools in ArcGis. There are two methods of overlaying these data, one is the overlay of vector data (point, line, polygon), and the second is the overlay of raster data. However, both methods can be used to analyze certain areas that meet certain criteria, but the most appropriate one is the overlay of raster data.

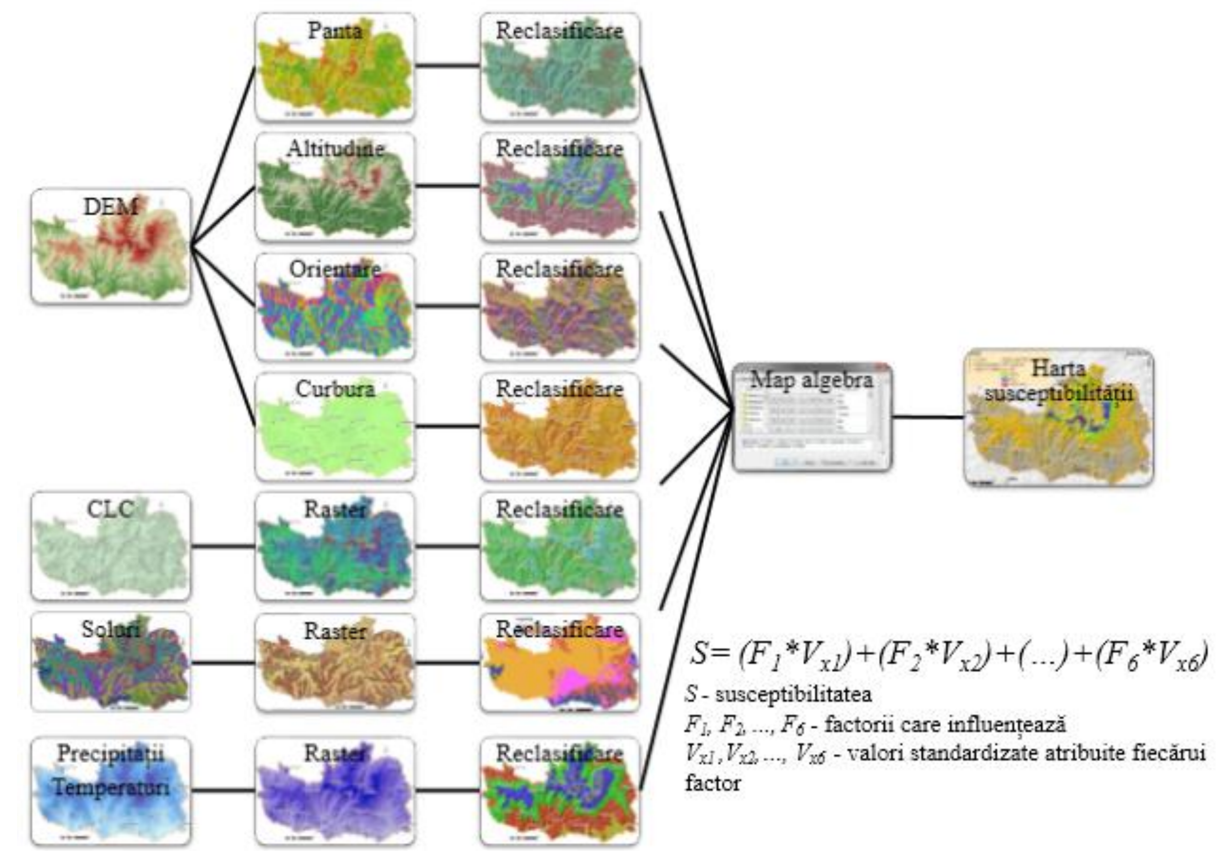

Figure 1 The scheme of obtaining the susceptibility maps

Attributing Favorability Coefficients

Each parameter taken into account was subdivided into different classes, depending on its influence on the susceptibility to the dangerous phenomena studied. The assignment of these values was based on the numerous studies on the frequency of these processes on certain slopes, depending on the orientation of the slopes, the amount of rainfall, etc. Such an example is given by the study done in the Italian Dolomites (Ghinoi, Chung, 2005) where, depending on the normalized frequency of avalanches, the most susceptible areas to snow avalanches were determined.

In this respect, the Analytical Hierarchy Process (AHP) was used to obtain the coefficients, which is a method based on the favorable score, which allows not only a clear hierarchy of the analyzed elements but also the evaluation of each element within the established hierarchy. In other words, this method is perfectly suited to the present study, precisely because of its ability to convert empirical data into mathematical models, which gives it a distinctive mark compared to other methods that could have been used.

A clear example of how the AHP method has been successfully used is the assessment of the slope orientation as a triggering factor of avalanches. The basis of awarding the values to each criterion were the specialized studies which expressly refer to the possibility of producing a snow avalanche depending on the slope orientation.

These quantitative estimation methods ultimately led to the development of an empirical

Table 1 The slope orientation matrix

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Criterion 6	Criterion 7	Criterion 8	Standardized Value
Criterion 1 (N)	-	1/2	1	3/7	3/7	5/8	1/2	2	0,0821
Criterion 2 (NE)	2	-	5/8	3/7	3/7	1/2	3/7	1	0,0816
Criterion 3 (E)	1	1 3/5	-	5/8	3/7	5/8	1/2	1 3/5	0,0935
Criteriul 4 (SE)	2 1/3	2 1/3	1 3/5	-	1/2	1 3/5	1	2 1/3	0,1605
Criterion 5 (S)	2 1/3	2 1/3	2 1/3	2	-	2	1 3/5	2 1/3	0,2205
Criterion 6 (SV)	1 3/5	2	1 3/5	5/8	1/2	-	1/2	2 1/3	0,1234
Criterion 7 (V)	2	2 1/3	2	1	5/8	2	-	2 3/5	0,1738
Criterion 8 (NV)	1/2	1	5/8	3/7	3/7	3/7	2/5	-	0,0646

model based on numerous frequency studies. Starting from this, the Analytical Hierarchy Process (AHP) was used to obtain the coefficients, a method based on the favorable score determination, representing a structured technique for solving complex decisional problems. This type of analysis was developed by Thomas L. Saaty in 1970, since then being extensively used in the assessment of decision-maker factors (Zhang X., Wang Z., Lin J., 2015). AHP is a mathematical method that analyzes complex decisional issues (Chhetri, SK, Kayastha, P. 2015) being useful for verifying the consistency of the evaluator's judgment, helping to reduce subjectivity or bias in decision-making (Desert J. et al 2010, Nefeslioglu H.A. et al., 20013). GIS techniques, and in particular GIS-based multi-criteria decision analysis (GIS-MCDA), have increasingly become an integral part of urban, regional and environmental planning over the past 30 years (Zhang X., Wang Z., Lin J., 2015).

Using this analysis required the following steps:

- Defining decision criteria in the form of a hierarchy
- Establishing priorities among hierarchy components
- Thus, the decision matrix is obtained and by normalizing the amounts, the standardized values for each criterion result

THE TOURIST POTENTIAL OF CALIMANI MOUNTAINS

The landscape of Calimani Mountains is characterized by a great diversity and spectacularity. Thus, Călimanul has imposed itself by its massiveness to the surrounding regions, rising above Bîrgău Mountains (200-400 m) and the hills of the Transylvania Plateau (400-500 m). The unevenness and individualization of Călimani mountains are highlighted by the presence of depressions carved into less resistant rocks such as Colibița or those of erosion, collapse and volcanic dam: Toplița, Stînceni, Neagra, Lunca Bradului, Răstolița situated in Mureșului gorge; Drăgoiasa, Bilbor, Secu in the eastern part, and in the north Țara Dornelor (Naum T., Butnaru E., 1989). The importance of the landscape in tourism activity is given by the number and diversity of forms that display multiple attractions. Among those present in Calimani Mountains are the following: steeples, ridges, trenches, defiles, gorges, volcanic calderas, valleys, caves etc.

The specialty literature (Naum T., Butnaru E., 1989, Dincă, 2004, Gherman A., 2012) points out that despite the territorial extent, the geographic units can be relatively easy to identify. Thus, two large entities are distinguished: a central-axial one and the volcanic-sedimentary area. Also in the mountainous region of Călimani, we can distinguish three areas with distinct aspects: an intensely twisted inter-fluvial landscape, modeled in volcanic agglomerations; a stacked plateau of agglomerates and lava flows; the central caldera, surrounded by steep slopes and the dome that dominates the plateau.

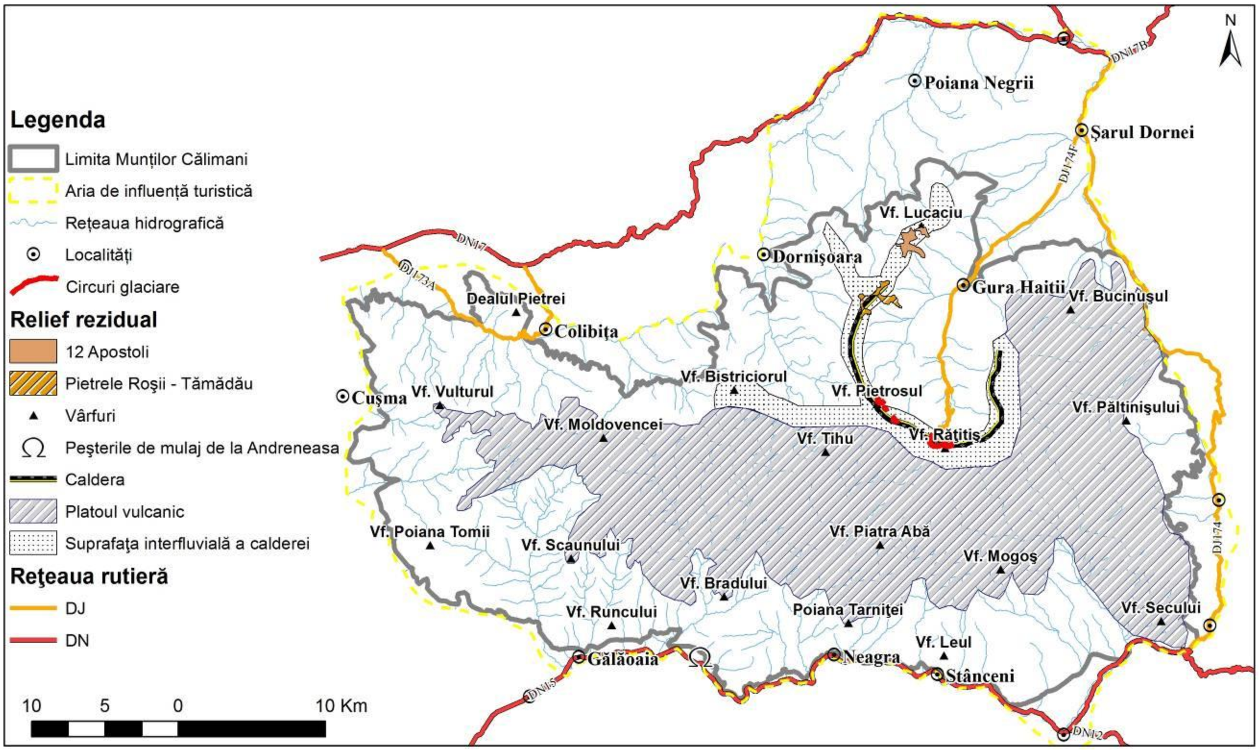

Figure 2 The main geographic forms

RISKS AND NATURAL HAZARDS IN CALIMANI MOUNTAINS

Identifying and analyzing dangerous phenomena are important issues in the development of tourism activities of all kinds. The latter are directly affected, sometimes with very serious effects, ultimately leading to a significant reduction in the number of tourists. The effects of natural hazards occur both materially (infrastructure) and on a human level (body injuries, panic or even loss of life). Therefore, the importance of risk analysis is directly proportional to the effects it can have on tourism activity.

A first step in analyzing dangerous phenomena is their classification according to their presence in the studied area. Once this classification is established, they will be analyzed according to their relevance to the area under study. The stages of this assessment highlight the typology of hazards, the areas covered by them as well as their impact on tourism.

Geomorphologic hazards in Călimani Mountains

Soil erosion in Calimani Mountains

Soil erosion processes are present on different parts of the slope under the following conditions:

- heavy torrential rains with intense manifestations towards their mid or end;

- water resulting from the rapid melting of snow;
- a slope gradient (generally between 3 ° and 15 °) sufficiently inclined to allow water to drain, but not so inclined as to lead to water to stay in the runways;
- the materials constituting the upper part of the deposit, soil, rock, are poorly cohesive and record a certain degree of water saturation.
- lack of vegetation that retains water, preventing its leakage (Ielenicz M. 2004).

Erosion continuously contribute to land degradation consequences, including removal of land use. Anthropic intervention also plays an essential role, directly influencing soil erosion through deforestation or aggressive agricultural techniques. Although this phenomenon of soil erosion does not directly affect tourism activities, it can still have a negative impact on the natural tourism resource by totally or partially deteriorating it.

Over the last 40 years, a number of soil erosion analysis models have been developed. All these quantitative estimation methods ultimately led to the development of an empirical model that underpinned some of the models and future formulas. Its pioneers were Wischmeier and Smith (1965) who attempted to develop a model in which the soil erosion process was mathematically described. Thus, the new method has been called the Universal Soil Loss Equation (USLE), which estimates the amount of eroded soil, taking into account six factors:

$$E = R \cdot K \cdot L \cdot S \cdot C \cdot P$$

E - average annual erosion, R - the pluvial aggression factor, K - soil erodability factor, L – the slope length factor, S – the slope factor, C – the vegetation cover factor, P - Correction coefficient according to anti-erosion measures and works.

R - the pluvial aggression factor

Pluvial aggression is expressed by the potential of rain drops to move the soil particles, a process closely related to the intensity of the rain. The aggressiveness factor was approximated by the simplified empirical equation proposed by Van der Knijff, J.M. et al. (2000).

$R = a \cdot P_j/100$

Where:

R - the pluvial aggression factor

a – the relative value of rain aggression

P_j - annual rainfall (mm)

The R Factor

In order to calculate the R factor, we used the averages of the precipitations recorded throughout the area. These data were obtained from the WorldClim database. The obtained raster map was multiplied by 0.15, the relative value a rainfall aggression specific to the Oriental Carpathians proposed by Moţoc M. et al. (1975). The calculation was made using the ArcGis programme, the Raster Calculator tool.

K - soil erodability factor

They have been assigned some parameters according to a series of soil attributes (texture, structure, permeability). These values represent the resistance of the soil layer to the action of rain drops exerted on it.

L – the slope length factor, S – the slope factor

These two elements are calculated unitarily, thus becoming the topographical factor LS. Both the length and the slope can substantially affect the erosion rate. As in the case of other factors, the calculation of the LS coefficient has been subject to a large number of approaches depending on the tools or data available. All these empirical relationships are used to determine this factor starting from the standard USLE equation

LS = (λ/72.6) m (65.41 sin2 Ɵ + 4.56 sin Ɵ + 0.065

This factor was obtained in ArcGis using the formula:

LS= Power (“flowacc”*[cell resolution]/22.1,0.4)*Power(Sin(“sloperaster”*0.01745))/0.09, 1.4)*1.4

Flowacc – possible flow accumulation

Cell resolution –raster resolution

Sloperaster – slope map

C - the vegetation cover factor

When assigning the values to factor C, we took into account those used in the specialty literature, the most objective values being attributed in 2015 by the group of researchers (Panos Panagos, Pasquale Borrelli, Katrin Meusburger, Christine Alewell, Emanuele Lugatoa, Luca Montanarella) from the Institute of the Environment and Sustainability of the European Commission.

P - Correction coefficient according to anti-erosion measures and works.

Due to the lack of work or at least of some policies that support landscaping in order to protect the superficial layer, factor P is assigned a value of 1.

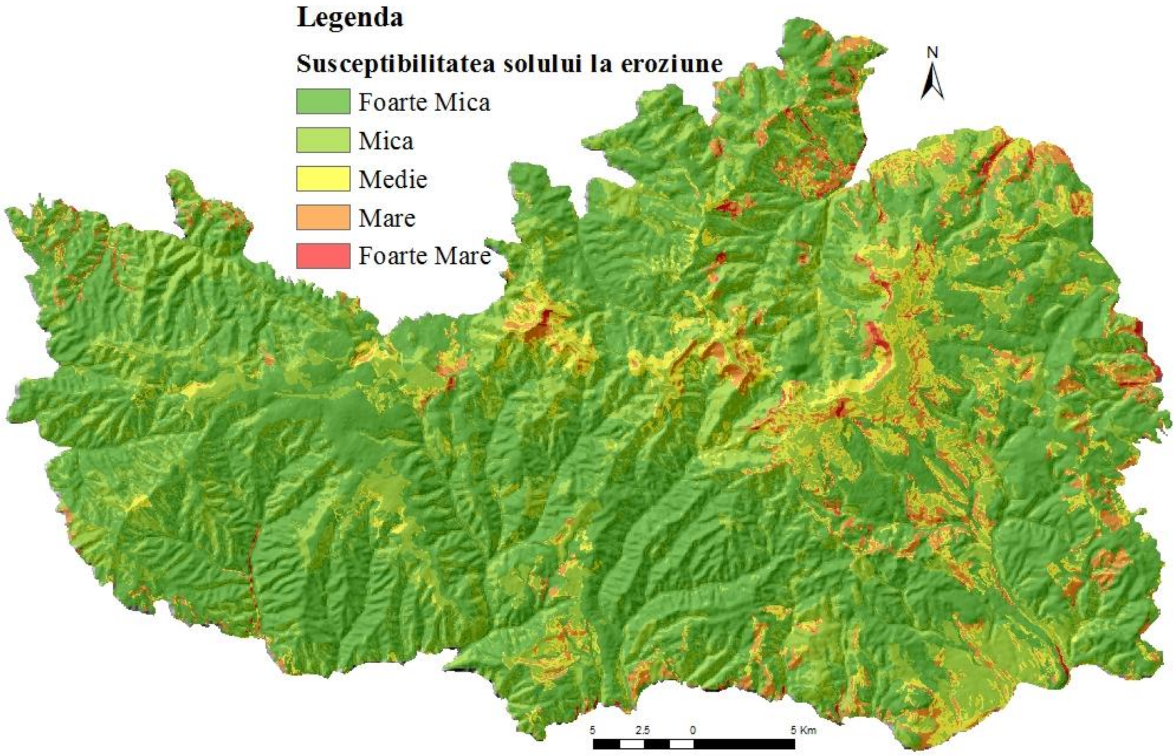

Figure 4 Soil susceptibility to erosion

Debris flow and rock falls

The first step to create the susceptibility map of debris flow and rock falls, was to map a number of 193 areas with potential for such phenomena. These areas include steeps, torrential organisms, residual relief and mineral exploitations. This analysis is very difficult and requires a thorough knowledge of the area. Initially all these areas can be considered as being at risk. However, in order to better assess the risk, other parameters that may favor the occurrence of debris flow and rock falls have to be taken into account.

The first parameter introduced was the one related to the slope gradient, which is the most important one. The deeper the slope, the more gravity manifests itself more strongly and vice versa (Rădoane, Maria, Dumitru D., Ichim I. 2006). Thus, five risk categories were identified.

To highlight the frost-defrost phenomena the air temperatures in the months with negative averages were also taken into account. The final layer added, was that of land use, and has an opposite effect to the aforementioned, because in the wooded areas there is either the probability of these phenomena to decrease or at least to diminish the negative effects.

The new map obtained was categorized by the natural value data aggregation method. Group categories are identified as the best values similar to the group and which maximize differences

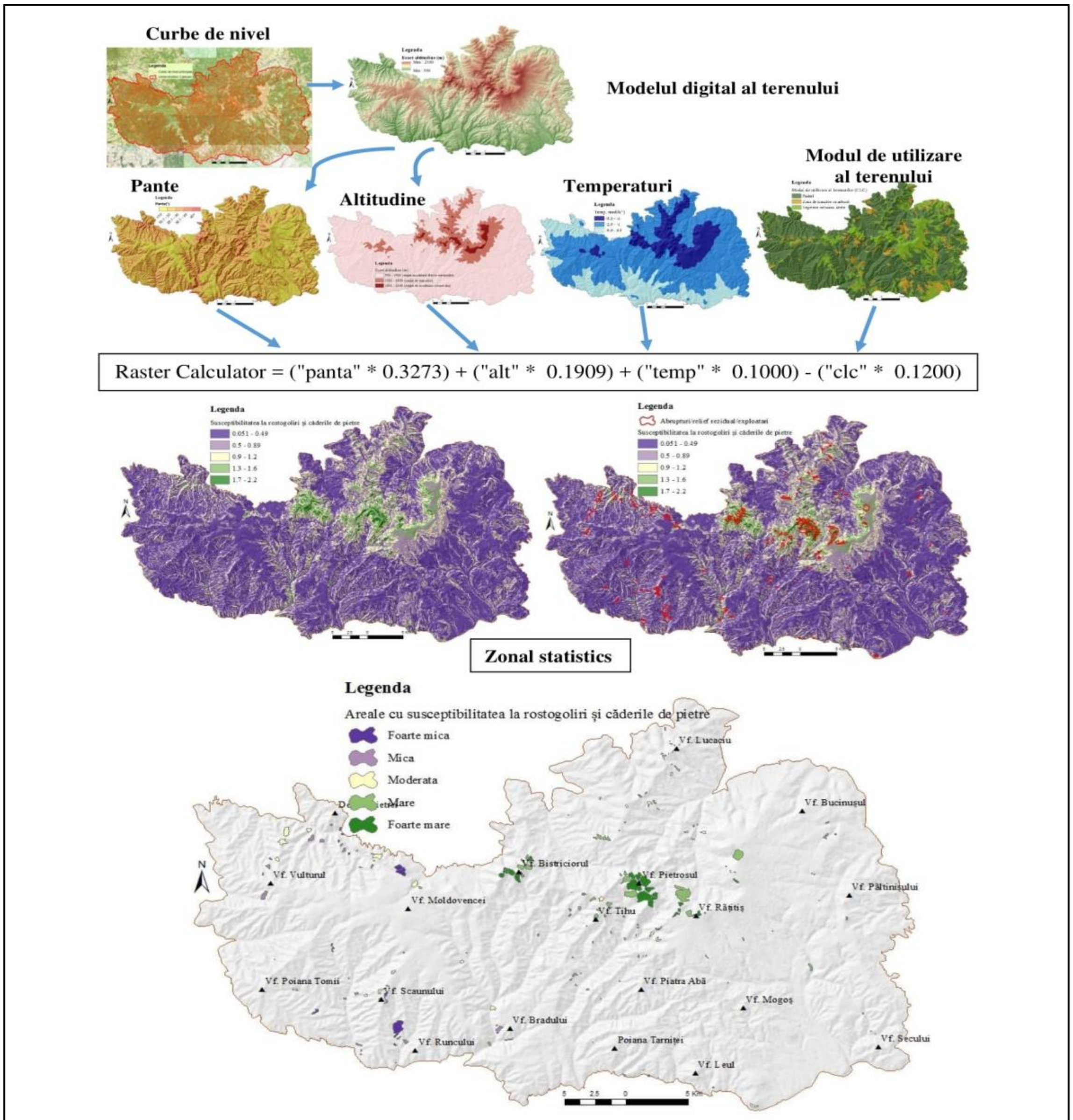

Figure 5 Scheme for obtaining a susceptibility map to debris flow and rock falls

between classes. The characteristics are divided into groups whose limits are established if there are relatively large differences between the data values.

Therefore, 5 susceptibility classes were obtained from very low to very high. Finally, using the "Zonal Statistics" tool, the data from the newly acquired map was taken, assigning to each mapped risk area, the specific susceptibility.

Severe weather phenomena

The free WorldClim database was used. As a result of the analysis of these data we obtained the distribution of temperatures over the whole area studied during all the 12 months of the year and the results obtained proved very useful in our analysis and implicitly in the generation of the susceptibility map to severe weather phenomena.

Along with the above-mentioned map we analyzed, by overlay, the rainfall distribution, temperature and land use. When it comes to precipitation and temperatures, things are pretty clear, i.e. susceptibility increases with altitude, and in the case of land use 3 large groups were identified. In the first group, the one that mitigates the effect of atmospheric hazards, included the forest lands, either coniferous, deciduous forest or mixed, the second group consists of transition areas with shrubs, and the last group and the one that is the most exposed to these phenomena is composed of areas with alpine vegetation, meadows or pastures and the agricultural land at the extreme end of the mountain massif.

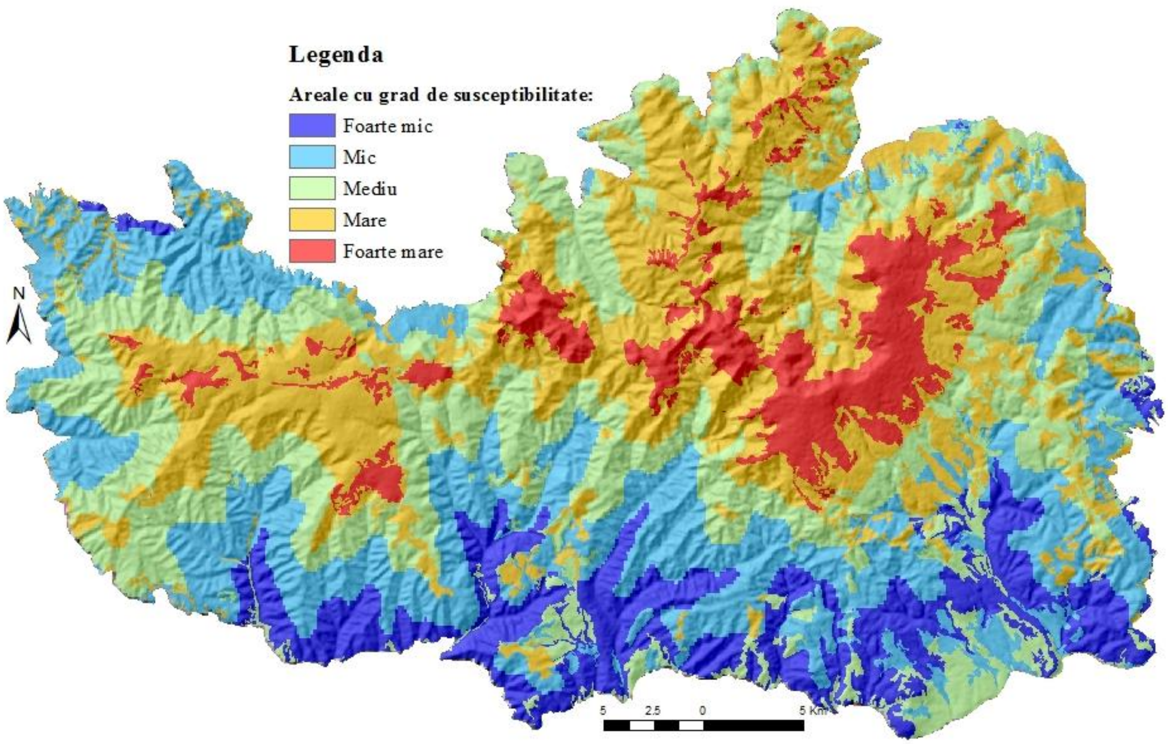

Figure 3 The susceptibility map to severe weather phenomena

Hydrologic hazards - areas susceptible to the acceleration of surface water leakage and implicitly in flood supply

The analysis method is identical to the above mentioned, the parameters taken into account for calculation are those of the soil type, slope, precipitation quantity, slope curvature, land use mode, slope length relationship and slope factor (LS factor). Each parameter was assigned a score of 1-5. In the awarding of credit assessments, we used the numerous studies on the identification of areas susceptible to accelerating the water surface spill. The one who proposed this type of analysis was Smith G. (2003), the method being taken over by many Romanian researchers: Mătreață M., Mătreață S. (2010), Teodor S., Mătreață S. (2011), Minea M. (2011), Zaharia L. et.al. (2012), Fontanine, I., Costache, R., (2013), Prăvălie, R., Costache, R. (2014), Miftode I.D., Romanescu G. (2017), etc. In the literature, this type of analysis is also known as the River Spill Rate.

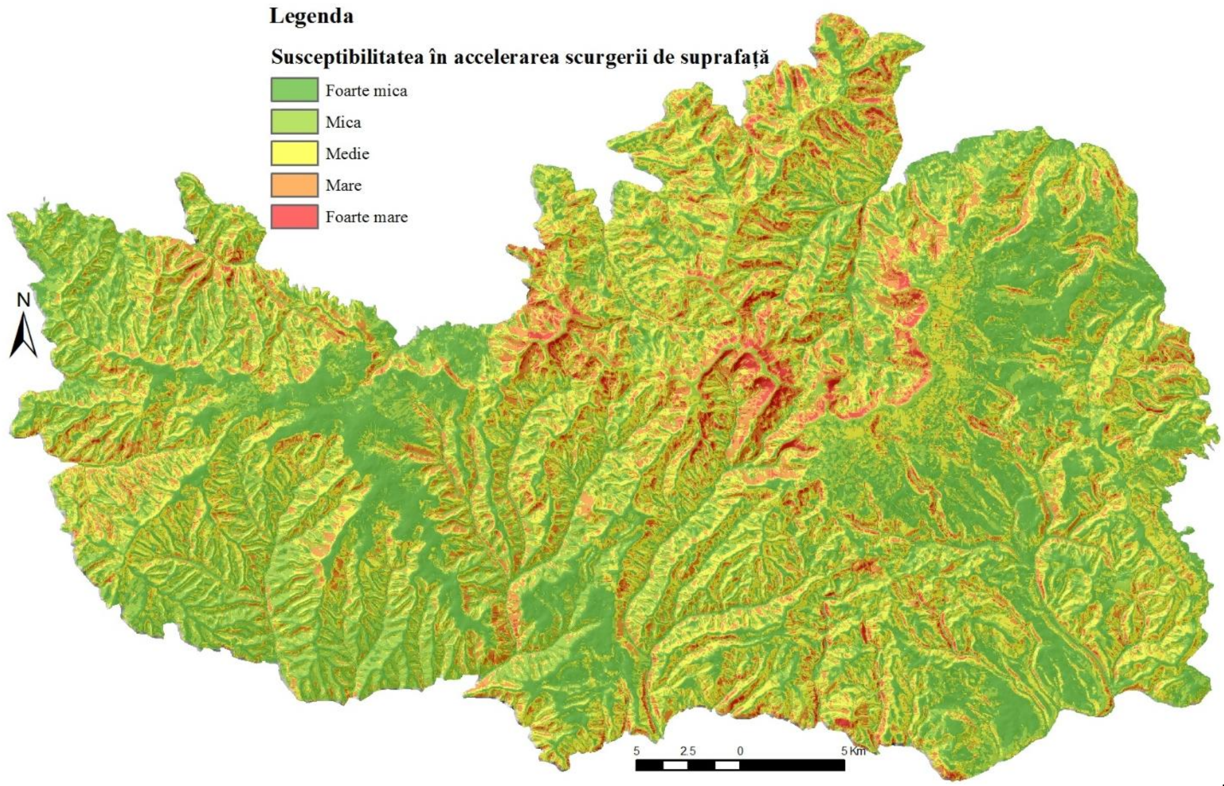

Figure 7 Susceptibility to acceleration of surface leakage

Snow avalanches

Two types of methods are used to analyze the susceptibility of an area to avalanches. The first type is related to the frequency analysis of these events. The main limitations of these techniques are the requirement for a representative number of samples and databases to determine the occurrence of these natural processes. In Romania, these data are incomplete and inaccurate, so this analysis is very difficult to achieve. The second methodology analyzes the distribution of factors that trigger the snow avalanches. Thus, the parameters taken into account are those related to altitude, gradient, orientation, curvature, land use, and the amount of precipitation. With this method, it is possible to determine areas susceptible to snow avalanches without temporal implications (Ozșahin E., Kaymaz K. C. 2014, Simea Ioana, 2012)

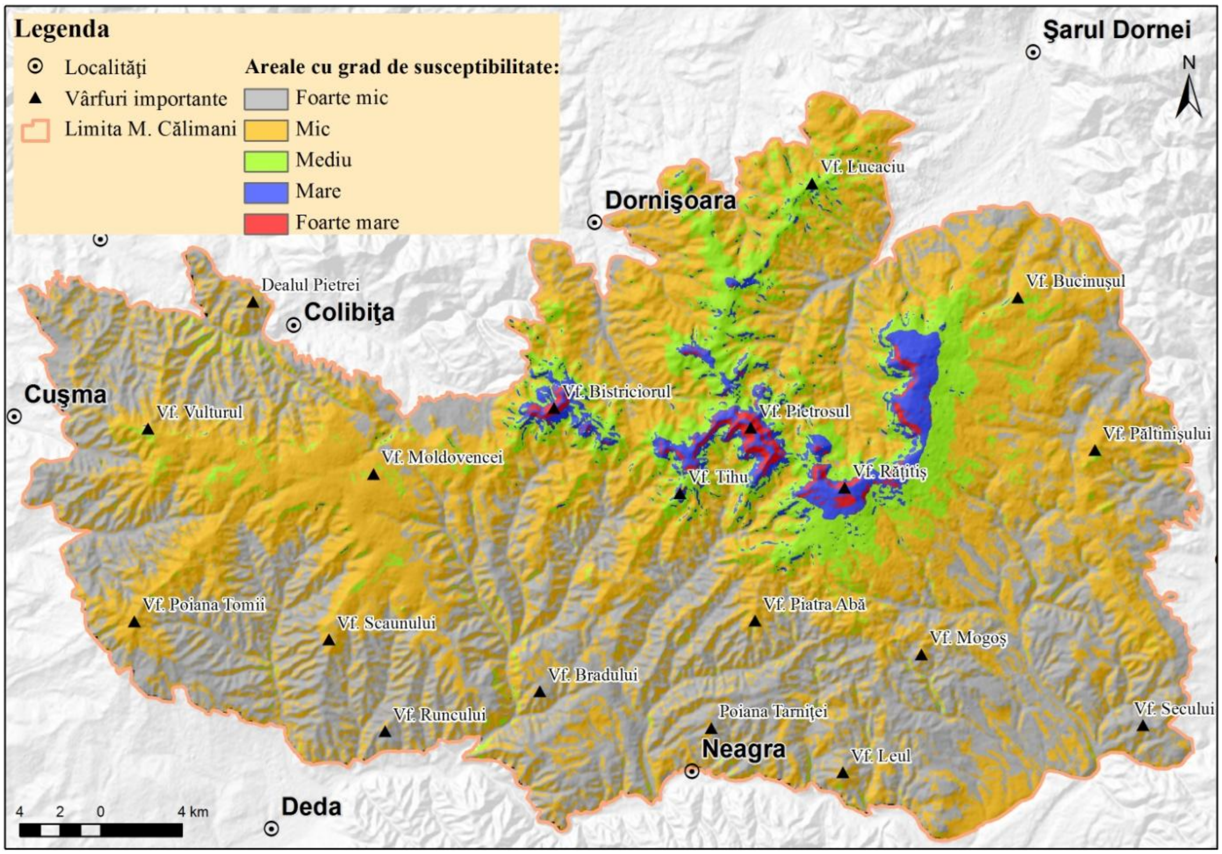

Figure 8 The susceptibility map to avalanches

The susceptibility of Calimani Mountains to dangerous phenomena

The method of analysis was the overlapping of susceptibility maps to severe weather phenomena, snow avalanches, accelerated surface water leakage, debris flow and rock falls and soil erosion. Their overlapping was done simply by adding them to the "mosaic to new raster" function of ArcGis. In order to avoid major differences, they were reclassified, with values ranging from 0 to 4, 0 representing the areas with a very low susceptibility, and 4 those characterized by a very high susceptibility in the occurrence of these phenomena. The classification method of the susceptibility levels was that of natural grouping of data values.

Two situations were analyzed to get the closest results to reality. On the one hand, the first situation is the one that is valid for the summer period, i.e. during the periods when there is no snow, which determines that the avalanche danger is non-existent. On the other hand, the second analysis also covers the layer with susceptibility to the production of snow avalanches.

In both cases, the most exposed areas are those at an altitude of over 1,600 meters, with a maximum on the Pietrosul - Negoiu Ungurесc peak and on the Zurzugău - Bistricior - Străcior. This can be explained by the meteorological factors that influence in turn the other parameters taken into account. Very high values were obtained also on the western slopes of the eastern caldera, on the northern slopes of Retitiş peak, for the same reasons mentioned above. Another dangerous area is that of the eastern slopes, Tamaului peak (Pietrele Rosii), here the particularity of the area is due to the presence of many forms of residual landscape. The same situation is found in the 12 Apostles

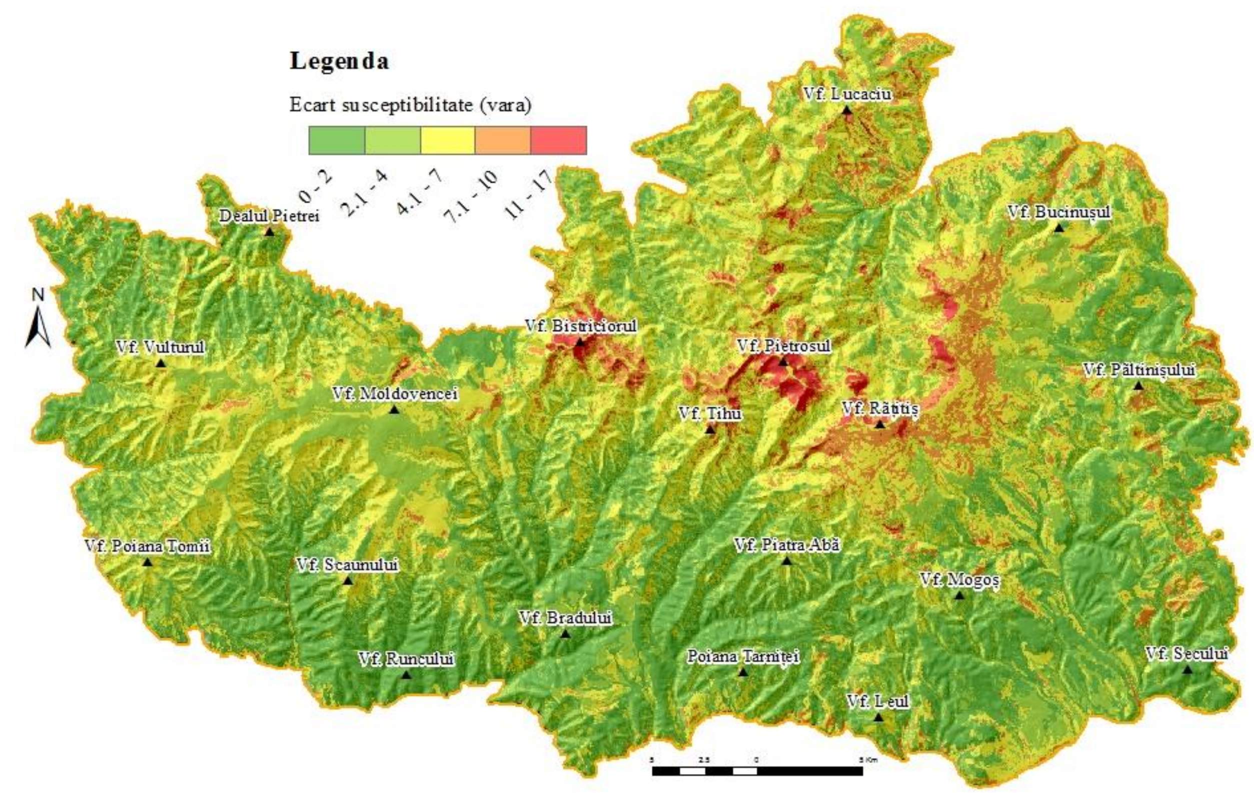

Figure 9 Susceptibility to hazardous weather phenomena (no snow cover)

tourist site, despite the fact that this site is at a much lower altitude, which implies milder meteorological conditions.

Areas with high values are found especially on the alpine meadows on the outer ridge formed by the peaks Retitiş, Bradul Ciont, Voivodeasa, Iezerul Călimanului and Călimanul Cerbului, the high susceptibility being given by their exposure to dangerous meteorological conditions such as strong winds, thunderstorms or heavy rains, all of which limit the tourist activity.

(statement sustained and reinforced also by the answers of those questioned about the dangers existing on the territory of the studied area).

Starting from the susceptibility map to the dangerous phenomena during the summer, the susceptibility values specific to the tourist trails could be outlined. To obtain them in the first stage,

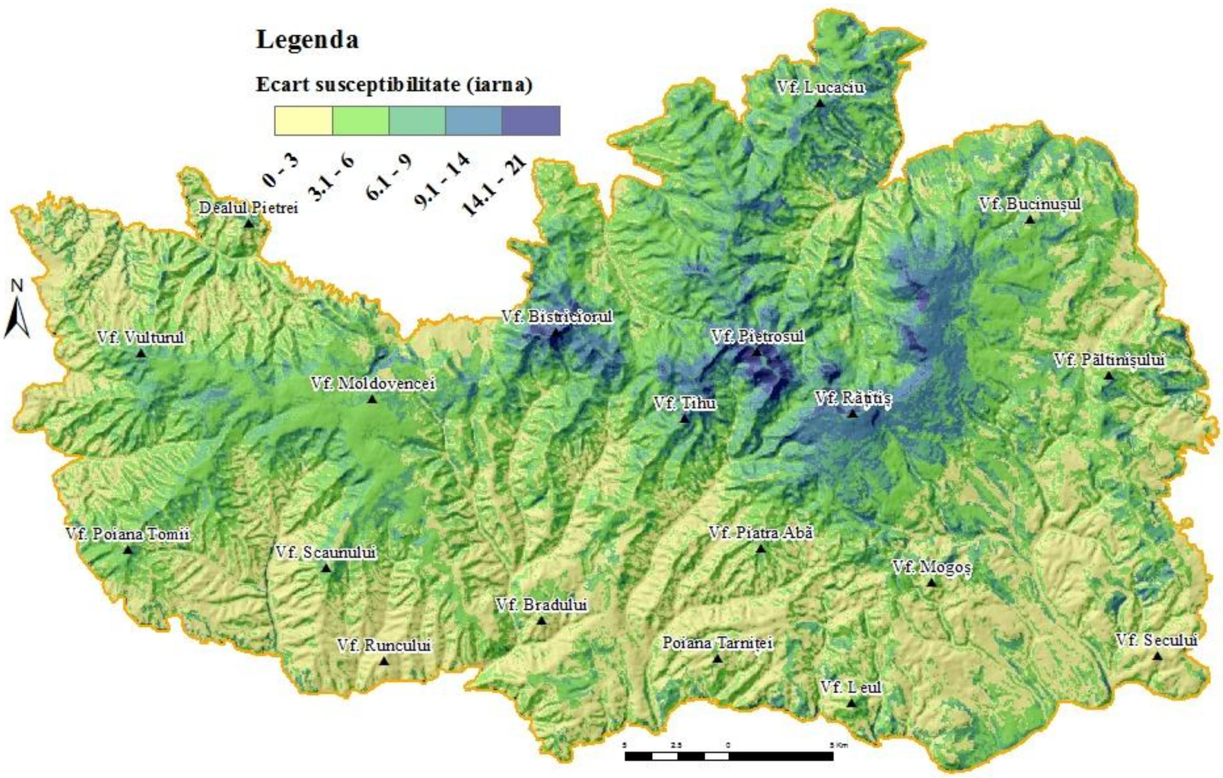

Figure 10 Susceptibility to hazardous weather phenomena (with snow cover)

the raster map was cut with the help of the "Extract by Mask" tool using line vector data containing the tourist trails. The second step has been to convert raster data into vector data by assigning to each point the value of the corresponding pixel on the raster map of susceptibility.

Another method of GIS analysis used to determine the susceptibility of mountainous tourist trails is that of converting line vector data, including mountain trails, into point vector data. The metric range between points was 20 meters. With the help of the latter, both the degree of susceptibility and the altimetric elevation of each point were extracted from the raster maps. Finally, processing of this data in Excel generated the chart of the tourist route by susceptibility classes.

Thus, the analysis revealed two areas with a very high and high degree of susceptibility, the first being the section of the trail at the foot of Bistriciorul ridge between Piciorul Negru and Piciorul Popii on a distance of about 5.6 km, while the second was represented by the sector on the north-eastern slope of Pietrosul ridge, with a length of about 5 km. This once again demonstrates not only that the working methodology is effective but also the need to require such studies in order to identify and highlight areas exposed to dangerous phenomena. At the same time, the present study demonstrated the possibility of creating susceptibility maps, particularly to emphasize the sections of trails where there are certain dangerous areas.

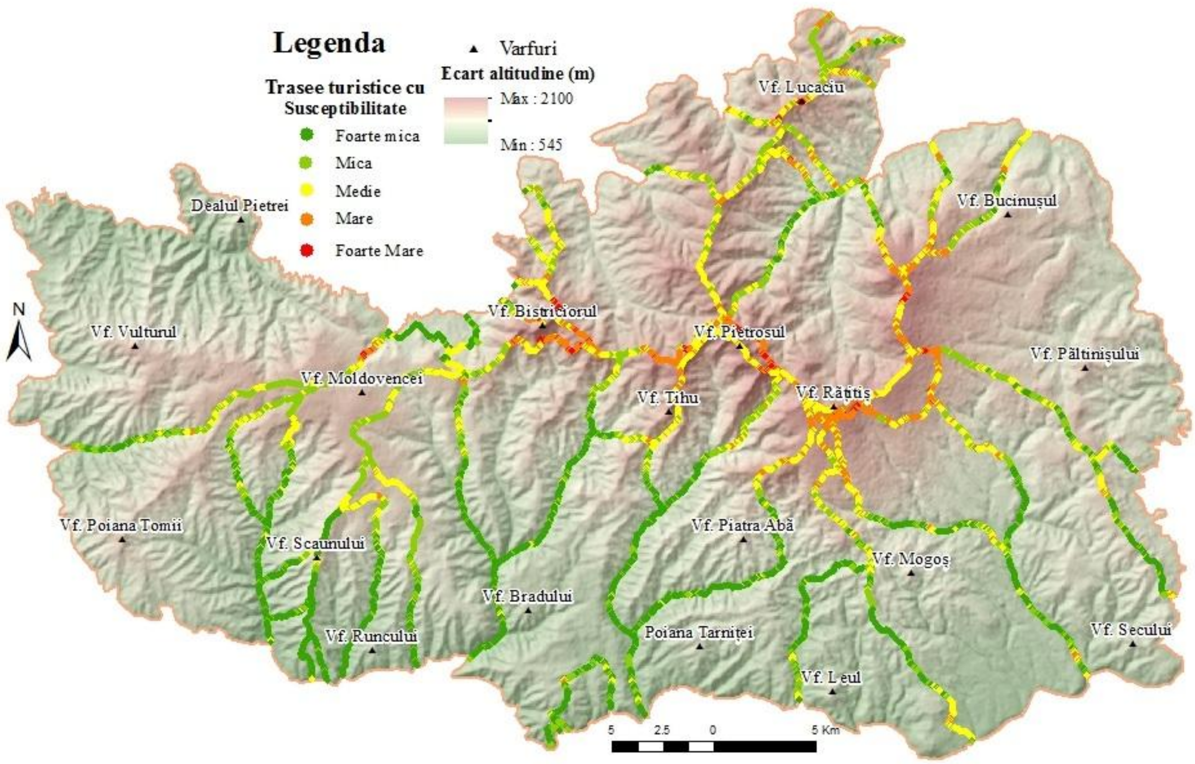

Figure 11 Mountain trails with specific susceptibility

EVALUATION OF TURIST SITES IN CALIMANI MOUNTAINS

The methodology underlying this study has started from the current specialty literature used on an international level, but many changes have been developed to adapt to the actual specific conditions of the Calimani Massif (poorly developed infrastructure, lack of the quantification the number of tourists, the lack of promotional policies, etc.). For this evaluation we have obtained a method that allows us to compare the tourist potential with the actual site use potential. Thus, on the territory of Calimani Mountains were identified 12 important tourist sites that we considered to meet all the conditions to be part of our analysis.

Several simple operations were used to obtain the final result. Thus, for the achievement of the total tourist value, the 5 factors of the scientific, aesthetic, cultural, economic and ecological value were summed up. In the same way, the score for limiting factors was also obtained. However, to obtain the total value of tourist sites, the Analytical Hierarchy Process (AHP) was used as a 1 to 2 ratio between limiting factors and the value of tourist sites. Analyzing the final values, one can notice that the site with the highest total value is represented by 12 Apostles totaling the highest score in two of the six evaluated features. At the opposite end is Lake Iezerul Călimanului and Tăul Zânelor, obtaining the lowest score caused mainly by their low aesthetic and economic value.

Table 2 Total value of tourist sites

Tourist site	VTur	Limiting factors		FL1+FL 2+ FL3	Vtur ponderate	Ponderate limiting factors	Total value
		FL+ FL3	FL1				
12 Apostoli	17.25	0.75	6.6	7.35	4.14	0.88	3.26
Cheile Bistriței Ardelene	14.5	0.75	4.11	4.86	3.48	0.58	2.90
Peșterile de mulaj de la Andreneasa	13.5	1.5	3	4.5	3.24	0.54	2.70
Vf. Rețitiș	14.5	0	8	8	3.48	0.96	2.52
Zurzugău – Bistricior - Străcior	15	0	10.53	10.53	3.6	1.26	2.34
Culmea Scaunului	12	0.5	4.35	4.85	2.88	0.58	2.30
Pietrosul – Negoiu Unguresc	15.25	0.25	12.53	12.78	3.66	1.53	2.13
Valea Repedea	10	0.25	3.71	3.96	2.4	0.48	1.92
The former sulfur exploitation	12.5	1	8.28	9.28	3	1.11	1.89
Tihu – Ruscii - Gruiu	12.25	0.5	8.57	9.07	2.94	1.09	1.85
Tăul Zânelor	9	1	3	4	2.16	0.48	1.68
Lacul Iezerul Călimanului	11	1.25	8.04	9.29	2.64	1.11	1.53

Peaks with high altitudes also enjoy increased tourist attractiveness, occupying the following places, but because of the conditions that lead to a greater number of dangerous phenomena (rock falls, severe weather phenomena), they have scored lower in this assessment. However, it should be noted that Tihu-Ruscii-Gruiu ridge cannot be ranked in this category as it does not enjoy the same high score as the other peaks, because of its poor tourist promotion (little known, lack of tourist marks).

ANALYZING THE NATURAL RISKS AS LIMITING FACTORS OF TOURISM ACTIVITIES IN CALIMANI MOUNTAINS WITH THE HELP OF QUESTIONNAIRES

The overall purpose of this survey was the need to obtain data and information on the state of tourism and the natural risks present in this area.

The questionnaire is structured into four categories as it follows: the first category encompasses personal information and consists of four questions for identification; the second category refers to the tourist's motivation to visit this tourist area; the following category of interest is about the knowledge of the characteristics of the tourist potential of Călimani Mountains; and the fourth category is represented by the presence of risks in various tourist sites in the area.

The first information was obtained from a total of 56 visitors from the studied area, of which 54% were male and 46% female. The average age of 28 years clearly shows that this area is mainly visited by young people, which is likely to prove once again the difficulty of tourist trails. Regarding the occupations of the respondents, they are quite diverse, with the higher education professions (teachers, managers, engineers, IT analysts etc.) predominating, being closely followed by students.

The second category of questions refers to the tourists' visit to Calimani Mountains. The results of the questionnaires show that only 30% are on their first visit, with the remaining 70% visiting the area at least once more, including people who come every year, two or three times a year. 95% of respondents said they spend one to three days, and this is also caused by the lack of accommodation facilities that could offer diverse and quality services. In addition, this indicates that tourists practice especially weekend tourism. Approximately half of those who spent more than one day in the studied area said they chose the tent to stay overnight, the other half opting for the cottage.

Table 3 Share of interest in tourist sites

Areal / tourist site	**Very low interest**	**Low interest**	**Average interest**	**High interest**	**Very high interest**	**I don't know the site**
12 Apostoli	0	0	3	33	54	10
Negoiul Unguresc - Pietrosul	0	0	7	27	63	3
Pietrele Roșii - Tămădău	0	3	7	33	30	27
Fosta exploatare de sulf	0	7	30	33	27	3
Tihu – Ruscii - Gruiu	0	3	20	30	30	17
Zurzugău – Bistricior - Străcior	0	0	20	20	43	17

Valea Repedea	0	3	13	20	27	37
Scaunului Peak	0	0	20	37	40	3
Cheile Bistriței Ardelene	0	3	3	33	31	30
Stâncile Tătarului	0	0	10	33	20	37
The mold caves from Andreneasa	0	3	27	20	30	20
Vf. Rețitiș	0	3	3	45	46	3
Tăul Zânelor	0	0	7	30	43	20
Lacul Iezerul Călimanului	0	0	27	33	40	0
Cascada Cofu (Pișoiu)	0	0	0	30	33	37

The third part of the questionnaire focuses primarily on the interest of tourists to the main tourist sites that have been analyzed in this paper.

The last set of questions refers to the safety of the tourists, the presence of certain phenomena and natural processes and the effectiveness of the protection measures in this area.

CONCLUSIONS

In this paper, it was intended to go through stages in a logical, transparent and well-grounded way, in order to achieve the goals presented from the beginning. It started from a series of concepts belonging to the two fields of study in which this work falls, tourism, but especially the phenomena of risk in the mountainous area, and by their corroboration we tried to prove and argue how and especially to what extent the risk phenomena are perceived as restrictive factors of tourist activity.

The systematic, empirical and critical analysis of the hypothesis regarding the relationship between mountain tourism and dangerous phenomena, shows and supports the link between the two areas, but especially the way they influence each other. In this sense, the combination of the theoretical research and the empirical research, based on the direct observation of the reality in the mountainous area, is meant to prove the idea advanced from the title of the paper, namely that the natural risks are limiting factors of the tourism activity in the mountainous area.

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